From the similarity of the flame spectrum to that of the sun in one case, and from the dissimilarity in the other, we may imagine that in the former case—that of sodium—we are dealing with a body easily broken up, while lithium and potassium are more resistant; in other words, in the case of sodium, and dealing only with lines recognised generally as sodium lines, the flame has done the work of dissociation as completely as the sun itself. Now it is easy to test this point by the method now under consideration, for if this be so then (1) the chief lines and flutings of sodium should be seen in the flame itself, and (2) the spark should pass through the vapour after complete volatilisation has been effected without any visible effect.

Observation and experiment have largely confirmed these predictions. Using two prisms of 60° and a high-power eyepiece to enfeeble the continuous spectrum *of the densest vapour produced at a high temperature*, the green lines, the flutings recorded by Roscoe and Schuster, and another coarser system of flutings, so far as I know not yet described, are beautifully seen. I say largely, and not completely, because the double red line and the lines in the blue have not yet been seen in the flame, either with one, two, or four prisms of 60°, though

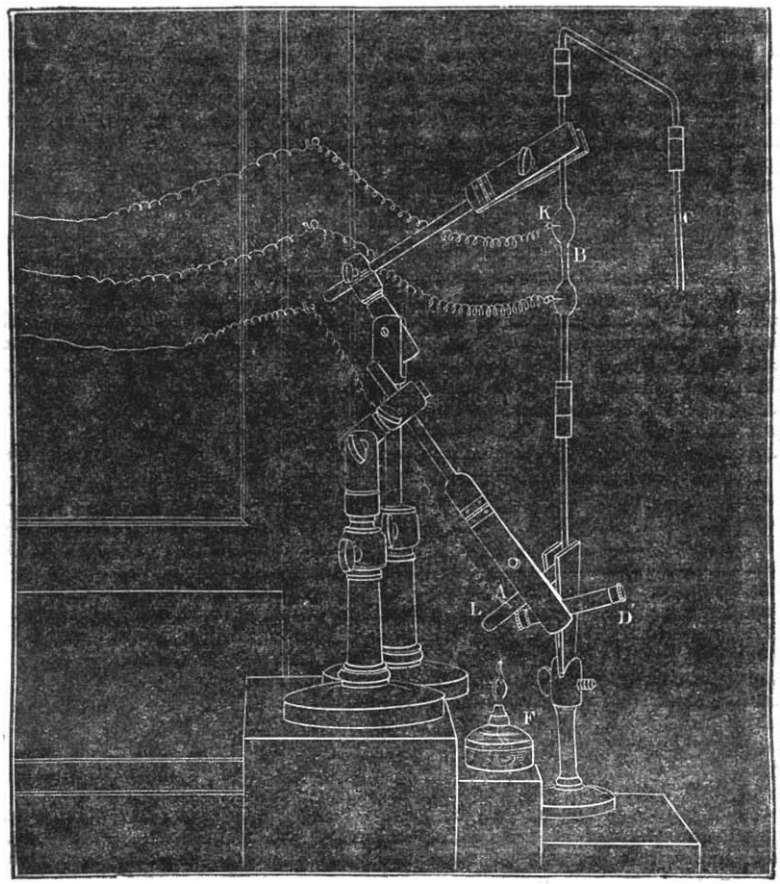

FIG. 3.—Position of Spectroscope for discovering Vapours close to the Metal.

the lines are seen *during volatilisation* if a spark be passed through the flame. Subsequent inquiry may perhaps show that this is due to the sharp boundary of the heated region, and to the fact that the lines in question represent the vibrations of molecular groupings more complex than those which give us the yellow and green lines. The visibility of the green lines, *which are short*, in the flame, taken in connection with the fact that they have been seen alone in a vacuum tube, is enough for my present purpose.

With regard to the second point, the passage from the heat-level of the flame to that of the spark after volatilisation is complete, produces no visible effect, indicating that in all probability the effects heretofore ascribed to *quantity* have been due to the presence of the molecular groupings of greater complexity. *The more there is to dissociate, the more time is required to run through the series, and the better the first stages are seen.*

J. NORMAN LOCKYER

(To be continued.)

WILLIAM LASSELL, LL.D., F.R.S.[1]

THE scientific world will receive with deep regret the intelligence of the death of this distinguished astronomer. The smaller circle of those who knew Mr. Lassell personally will deplore the loss of a friend of rare worth. Mr. Lassell passed away without suffering soon after five o'clock on the morning of Tuesday, October 5, in the eighty-second year of his age, full of years and greatly honoured and respected.

In the words of Sir John Herschel, Mr. Lassell "belonged to that class of observers who have created their own instrumental means, who have felt their own wants and supplied them in their own way." The qualities which enabled Mr. Lassell to do all this made him what he

[1] Based on an obituary notice written by the present writer for the *Times*.

was. The work was the revelation of the man. He felt precisely where lay the difficulties and wants which met him in his work, because he was sensitive and sympathetic. He could deal successfully with these difficulties, and supply these wants, often in a masterly and original way, because he could think for himself cautiously and yet boldly. He could work out his conceptions in new and difficult directions to a successful issue, because the constancy of his character showed itself here in concentration of thought and perseverance of action. These qualities, sensitive sympathy, wise prudence, constancy, were those which pre-eminently characterised him as a man and a friend.

In the history of science Mr. Lassell's name must rank with those of Herschel and the late Lord Rosse in connection with that essentially British instrument, the reflecting telescope, whether we consider the genius and perseverance displayed in the construction of these instruments, or the important discoveries which have resulted from their use. About 1820 Mr. Lassell, then in his twenty-first year, began to construct reflecting telescopes for himself. It is perhaps to circumstances which Mr. Lassell at the time considered most unfavourable that science is indebted for much that Mr. Lassell has accomplished. At that time he did not possess sufficient means to enable him to purchase expensive instruments, and besides "his business avocations were such as most men consider of an engrossing nature." The value to him in his subsequent work of the energy and power of resource which were in this way so strongly developed in his character at an early age it is difficult to appraise. His success with the two first instruments which he attempted simultaneously, a Newtonian of 7-inch diameter and a Gregorian of the same size, encouraged him to make a Newtonian of 9-inches aperture. The several mirrors made for this instrument were of great excellence. The observatory note-books of the late Mr. Dawes, which are in the writer's possession, bear record to the delicate tests for figure to which these mirrors were put on the occasions of the visits of Mr. Dawes to the observatory of his friend at Starfield, near Liverpool, where the instrument was erected.

The instrument may be said to form an epoch in the history of the reflecting telescope, in consequence of the successful way in which Mr. Lassell, on a plan of his own, secured to it the inestimable advantage of the equatorial movement.

About 1844 Mr. Lassell conceived the bold idea of constructing a reflector of 2 feet aperture and 20 feet focal length, to be mounted equatorially on the same principle. Mr. Lassell spared neither pains nor cost to make this instrument as perfect as possible, both optically and for the mechanical side. As a preliminary step he visited the late Earl of Rosse at Birr Castle, and commenced the specula for this instrument with a machine similar in construction to that employed by that nobleman. After some months work he was not satisfied with this apparatus, and was led, in consequence, to contrive a machine for imitating as closely as possible those motions of the hand by which he had been accustomed to produce perfect surfaces on smaller specula. "The essential difference of these constructions," to use the words of Sir George Airy, "as regards the movements of the grinder is this: that in Lord Rosse's apparatus every stroke is very nearly straight, while in Mr. Lassell's apparatus there is no resemblance to a straight movement at any part of the stroke." This is not the place to describe the many new contrivances in the mode of support of the mirror, in the equatorial mounting, and in the polishing machine, which enabled Mr. Lassell to bring this instrument to a high degree of perfection. I must not omit to notice, to use Sir John Herschel's words, "that in Mr. Nasmyth he was fortunate to find a mechanist capable of executing in the highest perfection all his conceptions, and prepared by his own love of astronomy and practical acquaintance with astronomical observation, and with the construction of specula, to give them their full effect." Mr. Lassell was very successful in the great brilliancy and permanency of polish of his metal. Within the last few years the writer has been shown specula by Mr. Lassell which had not been polished for more than twenty years, and which appeared as bright as if but just removed from the polishing machine.

With this fine instrument he discovered the satellite of Neptune. This minute body was first seen on October 10, 1846, but it was not until the next year that it could be satisfactorily followed and its existence fully confirmed.

The superiority of the telescope and the vigilance and skill of the observer were further shown by the discovery in 1848, simultaneously with Prof. Bond in America, of an eighth satellite of Saturn, of extreme minuteness, which was named Hyperion.

In 1851, after long and careful search, he discovered two additional satellites of the planet Uranus (Umbriel and Ariel), anterior to the two discovered by Sir W. Herschel in 1787. In the autumn of 1852 he took his 20-foot telescope to Malta, and observed through the winter of that year.

A most careful drawing of the nebula of Orion and drawings of several planetary nebula will be found in vol. xxiii. of the *Memoirs* of the Royal Astronomical Society. With respect to the planets, to use his own words, "his discoveries were rather negative than otherwise," for he was satisfied that without great increase of optical power no other satellite of Neptune could be detected. With regard to Uranus he says, "I am fully persuaded that either he has no other satellites than the four, or if he has they remain yet to be discovered."

Mr. Lassell's energy and zeal in the cause of science did not permit him to remain content with this magnificent instrument. His last work was a much larger telescope, four feet in aperture and thirty-seven feet focus, mounted equatorially. This grand instrument was erected at Malta in 1861, and the work done with it, with Mr. Marsh's assistance during the next four years, is fully described in vol. xxxvi. of the *Memoirs*. This work consists of numerous observations of nebulæ and planets and a catalogue of the places of 600 new nebulæ discovered at Malta. It is not possible to suppress a feeling of regret that this magnificent instrument no longer exists.

After his return from Malta Mr. Lassell purchased an estate near Maidenhead, and erected in an observatory his equatorial telescope of 2-feet aperture. Mr. Lassell's experience in repolishing his 4-feet mirrors suggested to him some alterations in his polishing machine. After his return he was able to carry out these experiments in a workshop erected at Maidenhead, and succeeded in constructing an improved form of polishing machine, which is described in the *Transactions* of the Royal Society for 1874. In 1839 Mr. Lassell was elected a Fellow of the Royal Astronomical Society, received its gold medal in 1849, and in 1870 was elected its president, which office he held for two years. He became a Fellow of the Royal Society in 1849, and received one of its gold medals in 1858. Among other honours conferred upon him may be mentioned an honorary degree from the University of Cambridge, and the honorary Fellowships of the Royal Societies of Edinburgh and Upsala.

The numerous papers by Mr. Lassell to be found in the *Monthly Notices* and the *Memoirs* of the Royal Astronomical Society bear abundant record to his industry and skill, and make us feel that in Mr. Lassell's death we have to deplore the loss of one who contributed largely to the advancement of the science of his age.

WILLIAM HUGGINS